

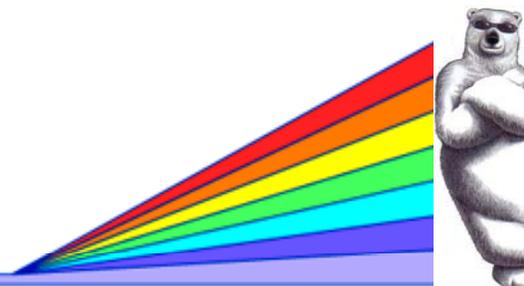
# Insertion Devices for Polarization Dependent Experiments

**George Srajer**

*Insertion Devices Workshop, December 5, 2002*

*Advanced Photon Source-Polarization Studies*

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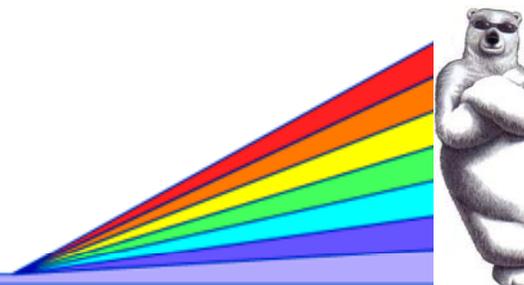
# Sector 4 Main Features

## Application/analysis of polarized radiation using

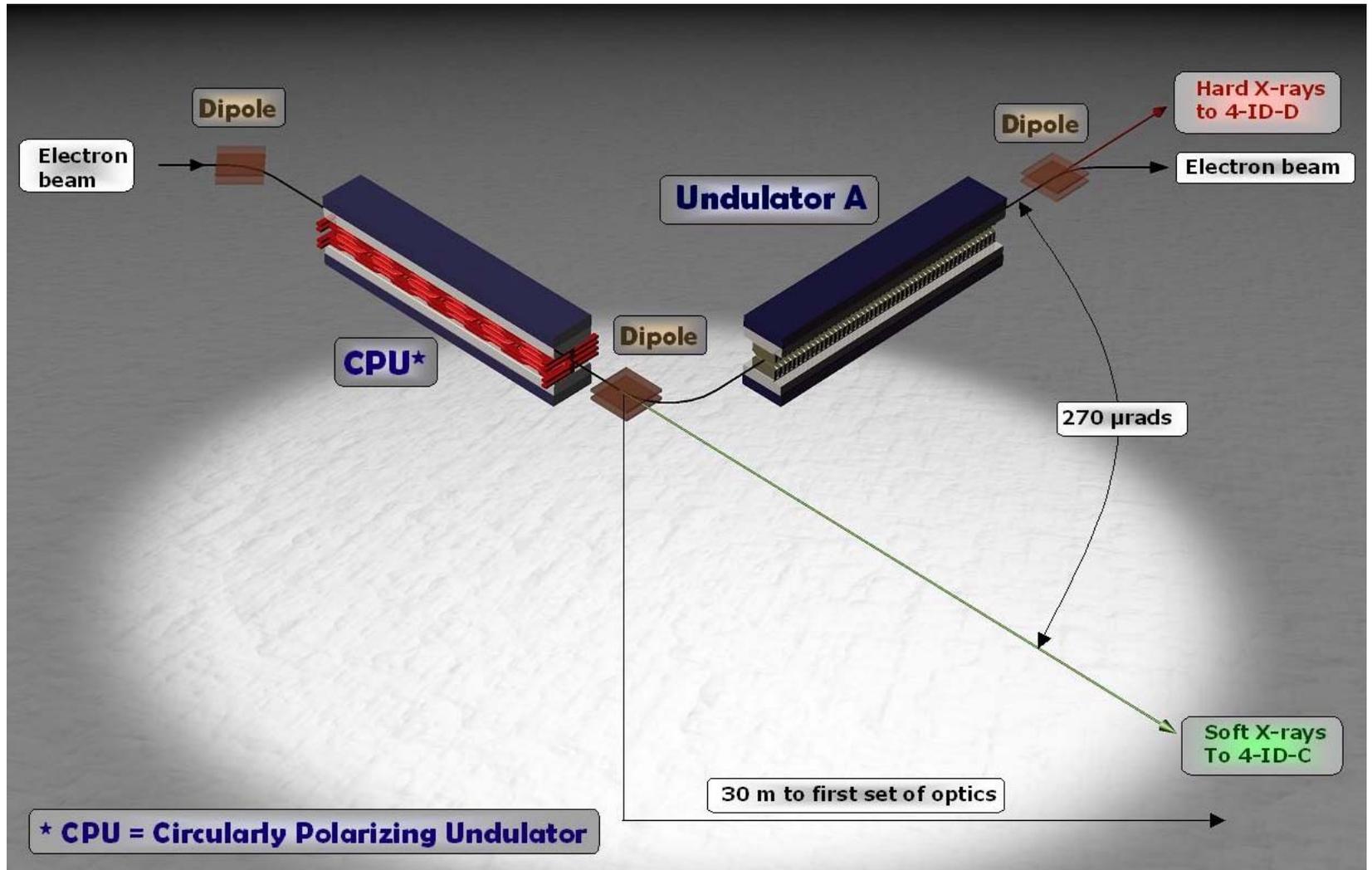
- ◇ scattering
- ◇ spectroscopy
- ◇ imaging

## Two independently operating branches:

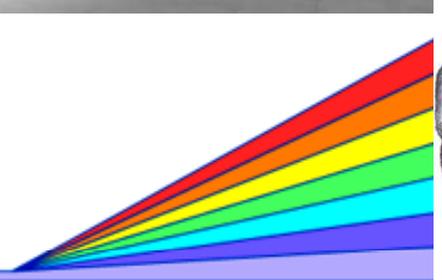
- 0.5 - 3 keV  $\Rightarrow$  circularly polarized undulator
- 3 - 100 keV  $\Rightarrow$  undulator A



# Canted Undulators in Sector 4



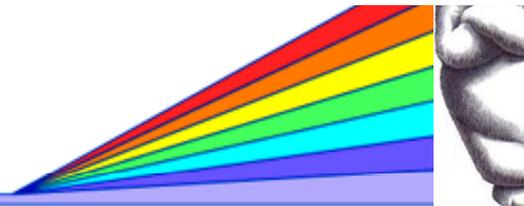
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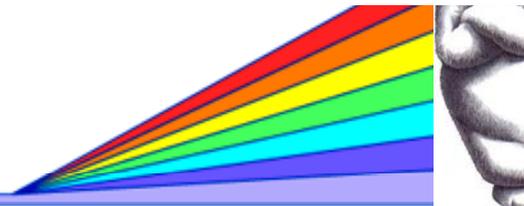
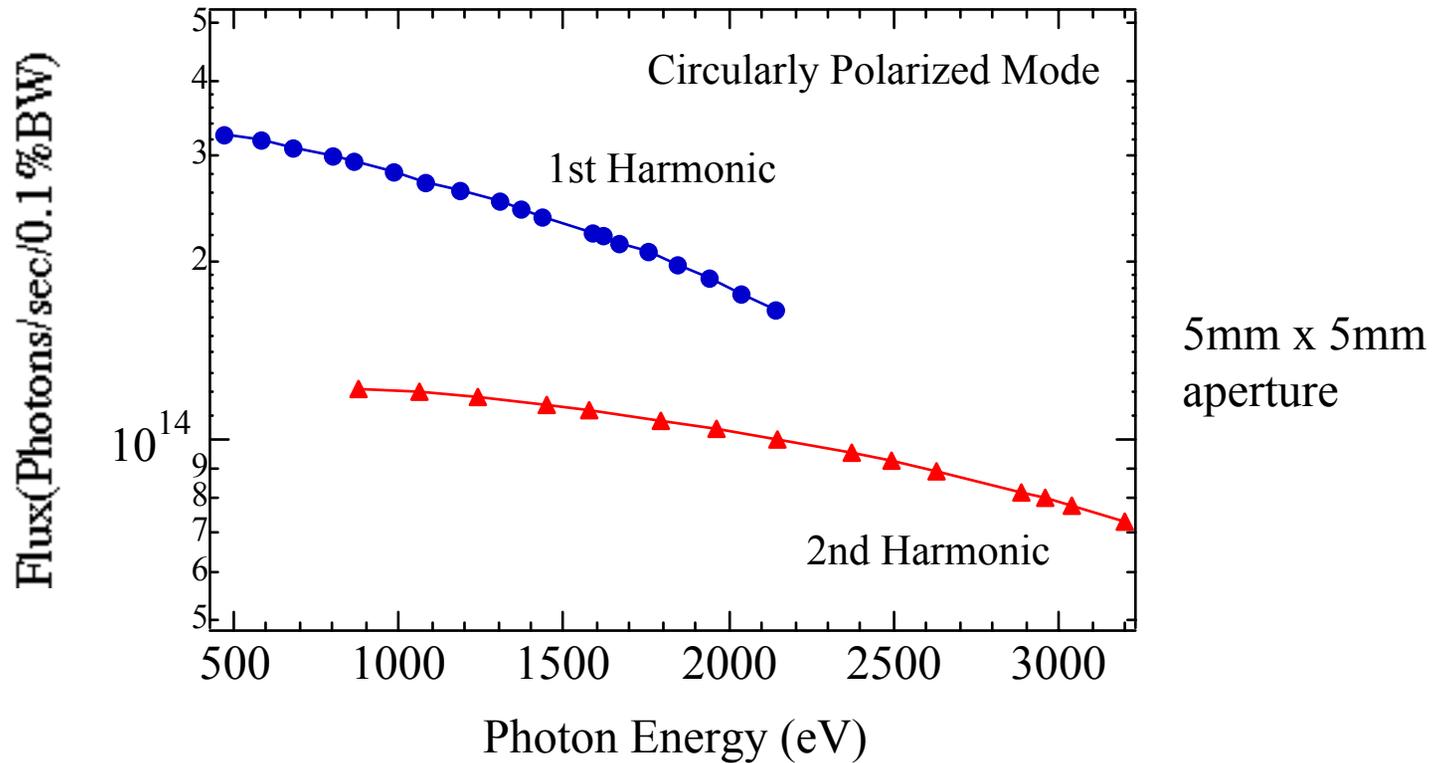
# Sources of Polarized Radiation

4-ID-C:  $\Rightarrow$  circularly polarized undulator

- Current operating mode : circular
- Frequency:  $\sim$  5 minutes to switch helicity  $\Rightarrow$  DC mode

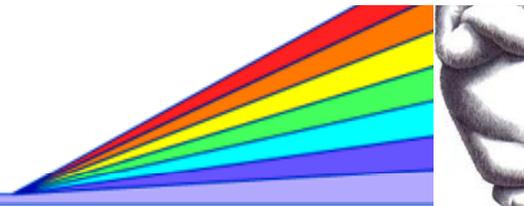


# Calculated Flux for the CPU



# Future CPU Needs (0.5 - 3.0 keV)

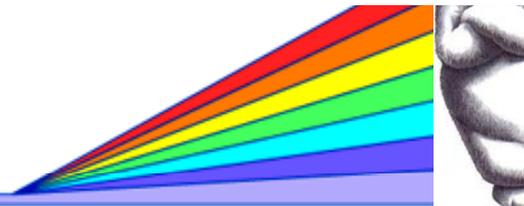
- Operate with linear modes
- Operate in AC mode up to 10 Hz



# Sources of Polarized Radiation, continued

4-ID-D:  $\Rightarrow$  undulator A + phase retarding optics

- Current operating mode:
  - ◇ 10.5 mm gap  $\Rightarrow$  Pd L-edge at 3.173 keV
- Helicity switching up to 40 Hz

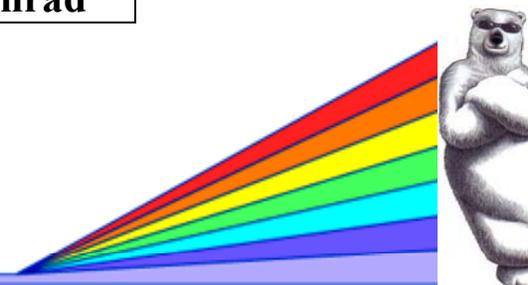


# Future Needs

- Extend lower energy range limit
  - ◇ 9.5 mm gap  $\Rightarrow$  S K-edge at 2.472 keV

Price:  $\Rightarrow$  lots of heat

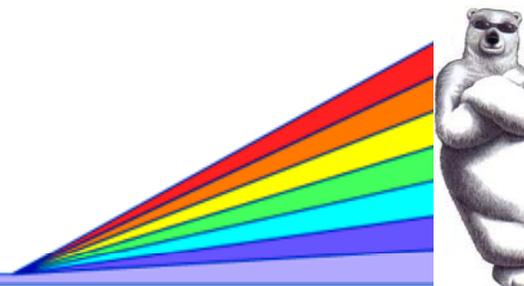
<b>100 mA beam current</b>	<b>Undulator A</b>	<b>CPU</b>
<b>Period length</b>	<b>3.3 cm</b>	<b>12.8 cm</b>
<b>Number of periods</b>	<b>72</b>	<b>34</b>
<b>Maximum K (at 9.5 mm gap)</b>	<b>3.175</b>	<b>2.75</b>
<b>Total power</b>	<b>7822 w</b>	<b>714 w</b>
<b>Peak power density</b>	<b>189 kw/mrad<sup>2</sup></b>	<b>19.9 kw/mrad<sup>2</sup></b>



# Heat load of FE components restrict operation at 9.5 mm

Yifei Jaski's Conclusion and Recommendation:

*At 100 mA, the undulator A in 4-ID is allowed to operate at the minimum gap of 9.5 mm ( $k=3.175$ ) with the condition that the **CPU is off**.*



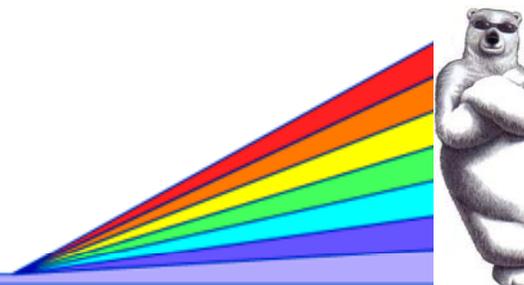
# Possible Solution

APPLE\*-type device:

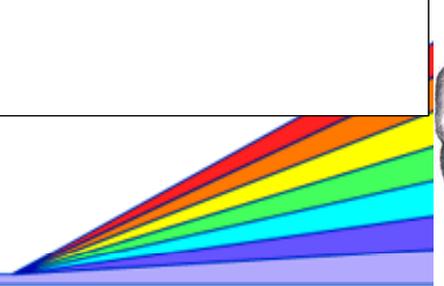
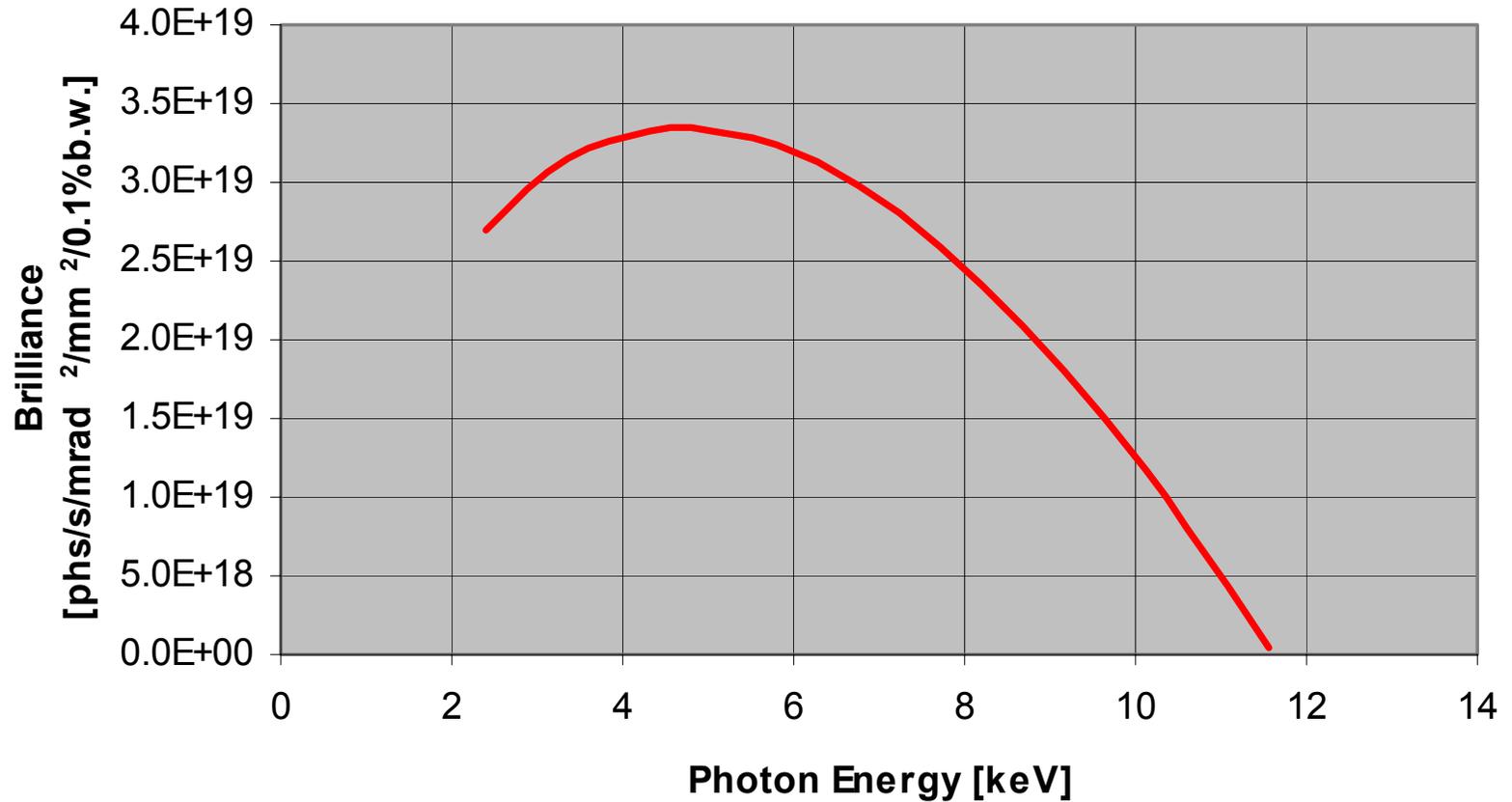
Energy tunability and manageable power load

- $\lambda = 4.0$  cm
- $N = 57$  periods

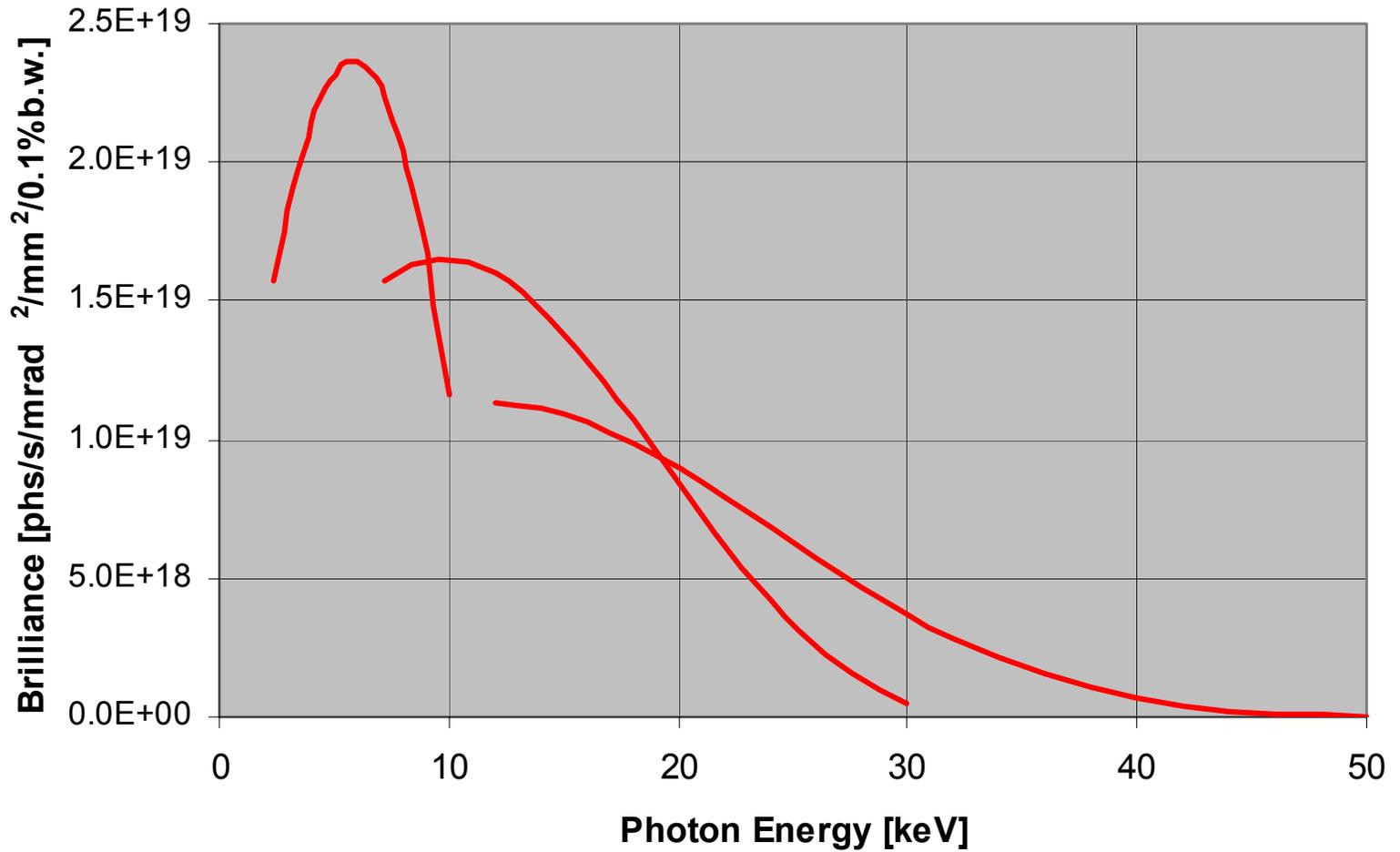
(\* S. Sasaki, NIM A **347**, 83 (1994))



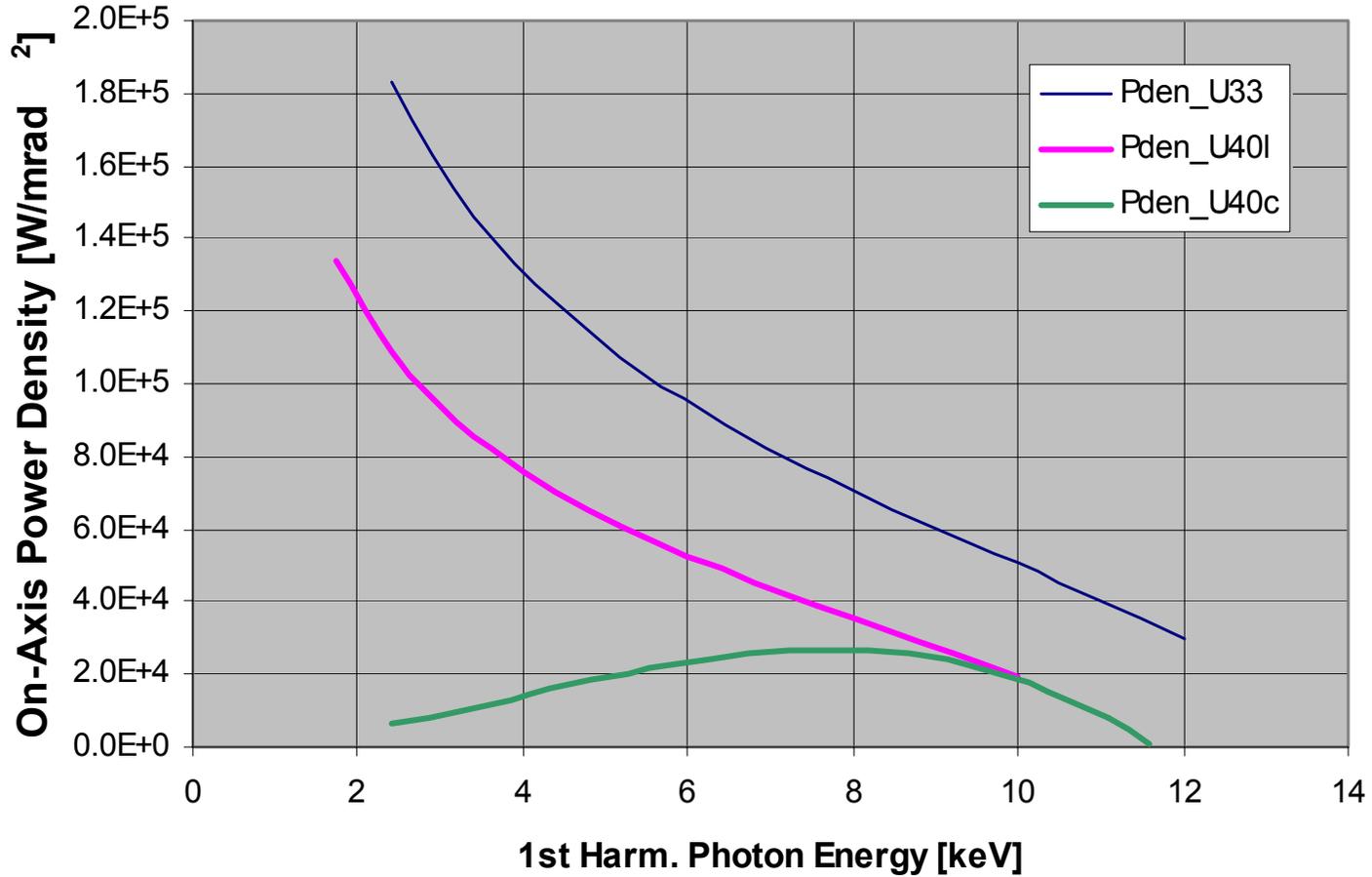
## APPLE-40 Tuning Range in Circular Mode minimum gap = 10.5 mm



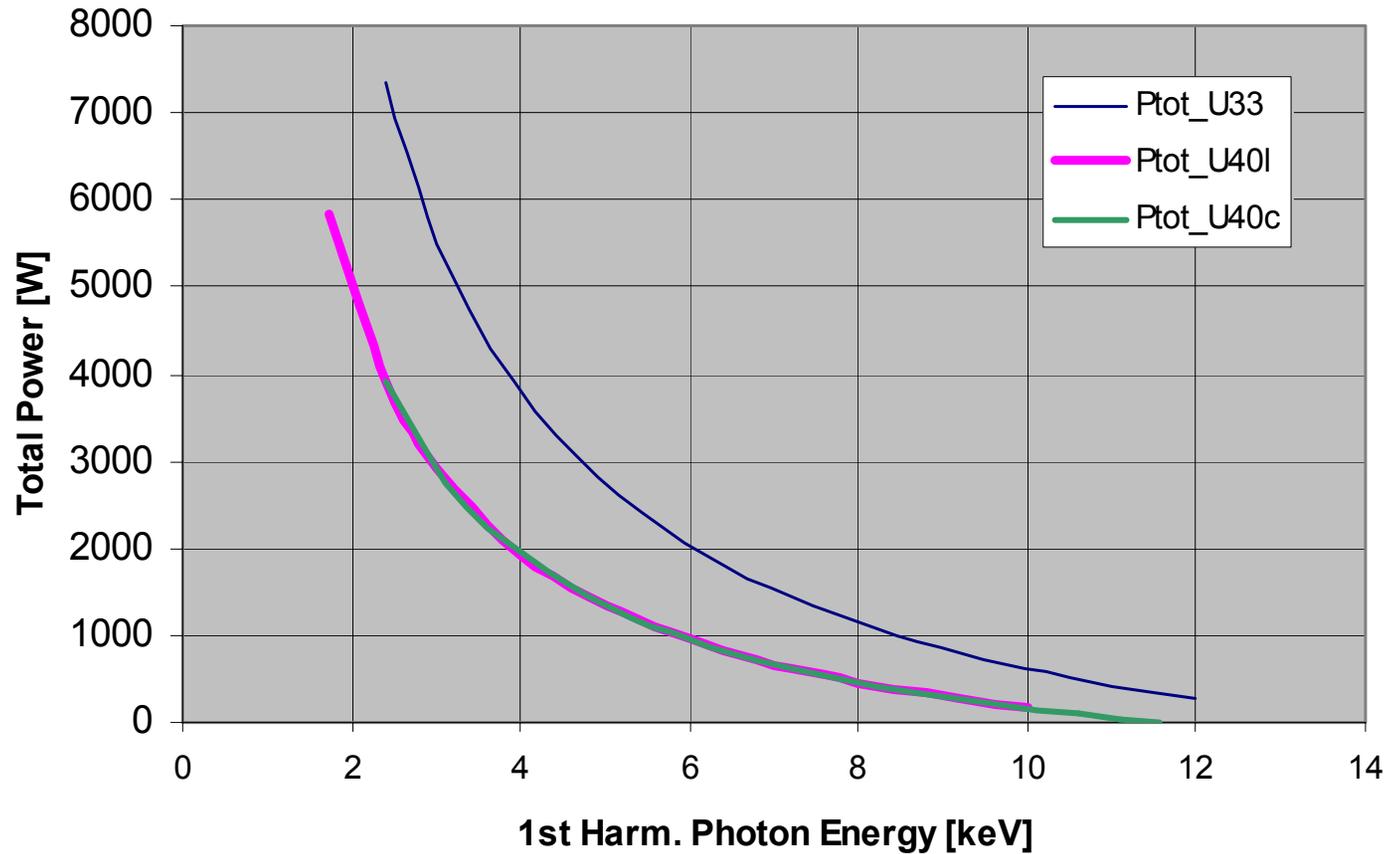
### APPLE-40: N=57, Linear Mode



## APS Storage Ring: 7 GeV, 100 mA

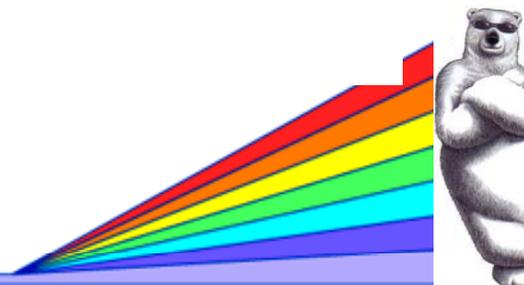


## APS Storage Ring: 7 GeV, 100 mA

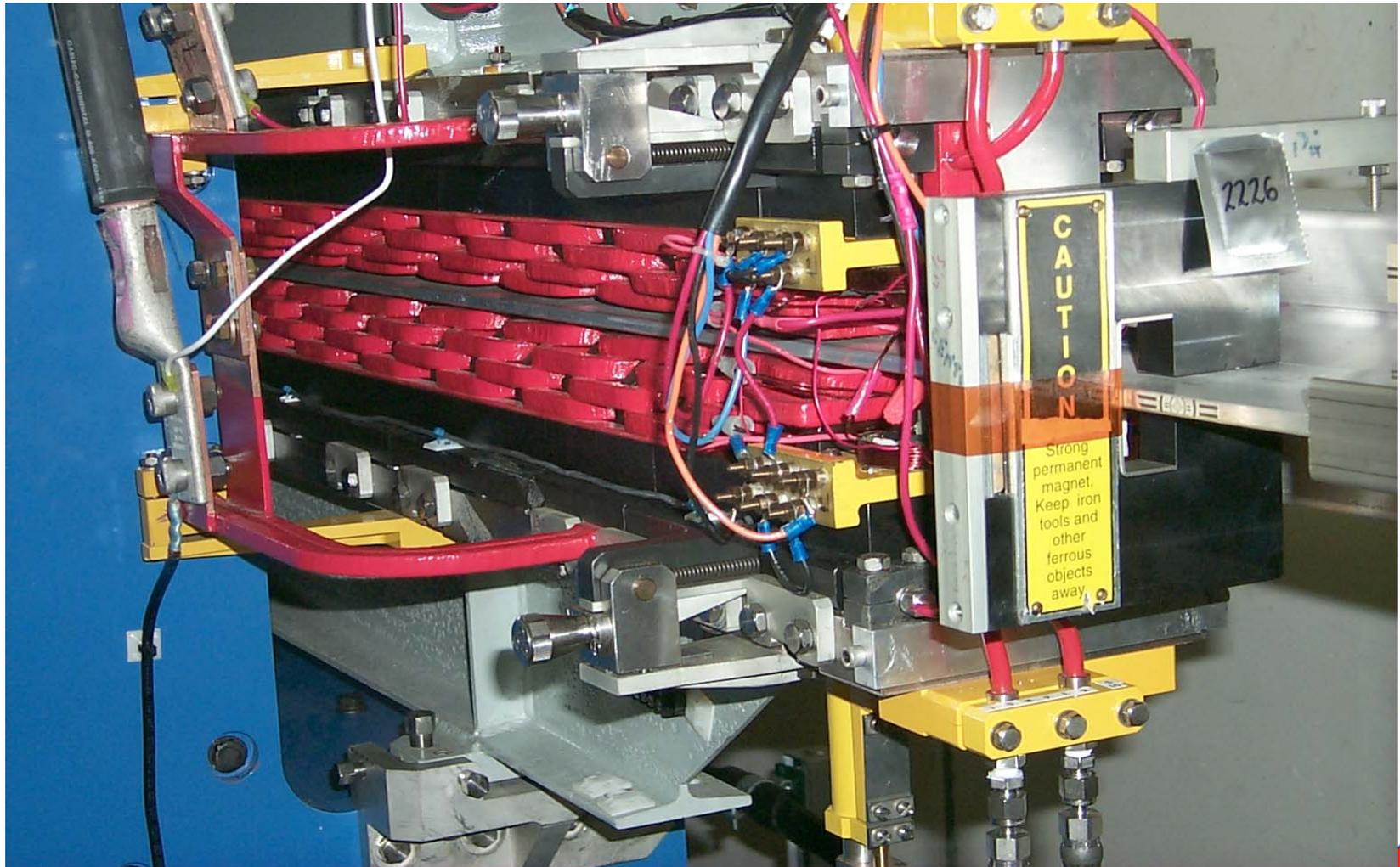


# Conclusions

- (1) Polarization sensitive experiments 0.4 - 2.5 keV
  - CPU is fine but need:
    - ◇ AC mode with CP operation
    - ◇ Linear polarizations, both DC and AC
    - ◇ Switching between LP and CP
  
- (2) Polarization sensitive experiments above 3.1 keV
  - Undulator A + phase retarder works fine
  
- (3) Polarization sensitive experiments below 3.1 keV
  - APPLE-40 device would work



# Circularly Polarized Undulator



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